

upper leaves, composed of about 6 partial panicles terminating the stem and branches, these 5 to 10 cm. wide, many-headed; bracts linear or spatulate, mostly 2 cm. long or less; pedicels 2 to 10 mm. long; heads about 12 mm. wide; disk campanulate, 8 to 10 mm. high, 4 to 5 mm. thick; involucre about 3-seriate, graduate, 5 to 6 mm. high, the outermost phyllaries small, linear-lanceolate, with very short dark acutish tips, the others oblong or oblong-obovate, stramineous, acute or apiculate, ciliate, carinate and nearly glabrous dorsally, with subscarios appressed tips; rays 5, pistillate, white, the tube pilose, 2 mm. long, the lamina elliptic or oval, 2 or 3-toothed, 6 to 9-nerved, sparsely pilose dorsally, 4.5 mm. long, 2.2 mm. wide; disk corollas about 23, white, erect-pilose at base of throat, otherwise glabrous, 4.5 mm. long (tube 1 mm., throat funnellform, 3 mm., teeth ovate, 0.5 mm. long); pales narrow, acute or apiculate, ciliate above, 7 mm. long; achenes (immature) narrowly cuneate-obovate, about 4 mm. long, 1.5 mm. wide, very narrowly 1 or 2-winged, the wings ciliolate, decurrent on the base of the awns; awns 2, somewhat, unequal, 2 to 2.8 mm. long.

Type in the U. S. National Herbarium, no. 1,152,183, collected at La Cebadilla, Department of San Salvador, Salvador, in 1922, by Dr. Salvador Calderón (no. 1206).

A species of the Section *Ochraetinia*, nearest the Guatemalan *V. punctata* Rob. & Greenm., which has the stems winged above with herbaceous wings up to 3 mm. wide.

ENTOMOLOGY.—*The North American bird parasites of the genus Protocalliphora (Calliphoridae, Diptera).*¹ RAYMOND C. SHANNON and IRENE D. DOBROSKY. (Communicated by S. A. ROHWER.)

This paper deals primarily with the systematic treatment of the North American species of *Protocalliphora*, a genus of flies which, in the larval stage, parasitizes nestling birds. Swallows, crows, sparrows, larks, robins, and allied passerine birds are the usual hosts of these blood-feeding larvae, but the host record of an owl is also included below. Many nestlings are killed annually by these parasites. An extended biological account of the group will be given in a subsequent paper by the junior author.

Our native species have always been confused with the European forms. They may, however, be immediately separated therefrom by the absence of hairs on the post alar declivity and on the tympanic membrane (located between the inner margin of the lower squama and lower squama of post alar declivity).

Two names have been applied to American material: *Protocalliphora (Calliphora) splendida* Macquart, described 1845, has rarely

¹ We desire to express our appreciation to Drs. J. M. Aldrich, O. A. Johannsen and J. Bequaert for suggestions and material. For bibliography see Bezzi, *Parasitology* 14: 29-46. 1922.

been referred to in literature; the other, *P. (Phormia) metallica* Townsend, is apparently synonymous with *splendida*. Three North American species, besides several subspecies and varieties, are here recognized. A rather remarkable condition of sexual dichromatism is presented by this genus. *Protocalliphora sordida* of Europe is dark metallic blue in the male while the female is entirely of a bronzy cast. The species here called *splendida* Macq. seems to have several types of coloration in the female. One phase of the coloration is nearly as dark metallic blue as the male (probably the normal coloration); in another the tip of the abdomen is of a shining brassy hue (presumably a variation from the typical color, but this is the characteristic point in both Macquart's and Townsend's descriptions of their material—females in both cases); and a third phase is entirely bronzy, dull on the thorax and shining on the abdomen. The color of the squamae is also variable, being white in the majority of specimens, a deep and somewhat golden yellow in others, especially in the bronzy forms, and quite dark in certain specimens (both sexes) which occur in the West.

The dark form with tip of abdomen shining bronze (brassy) is apparently widely distributed throughout the United States. Representatives are at hand from New Hampshire, Virginia, Illinois, Wisconsin, Idaho, Washington, Oregon, and New Mexico. No doubt it also extends into Texas. It is fairly safe, therefore, to assume that Macquart's *splendida* (described from Texas) is conspecific with this form. Townsend's name *metallica* should then be considered as synonymous with *splendida*.

Probably more subspecies and varieties and even species exist in the *splendida* group but the external and genitalic differences have so little that is tangible it is deemed best not to recognize more than are here included. Perhaps additional rearings will give some clue to the differentiation of the forms. We do not yet know how specific the forms are for particular species of birds. In making observations on the habits of these parasites one particular point should always be noted, i.e., whether the larvae are living as endoparasites or whether they live externally and obtain blood by inserting only the mouth parts in the flesh. It is thought the species may behave differently in regard to this habit.

In the key to the genera of Calliphoridae² *Protocalliphora* and *Phormia* are separated from *Protophormia* and *Boreëlus* on the basis of possessing white squamae. Since specimens of *Protocalliphora*

² Ins. Ins Mens. 9: 107. 1923.

occur with dark squamae the character "disc of upper squama bare" may be used for *Protocalliphora* and *Phormia* and "disc of upper squama thinly pilose" may be used for *Protophormia* and *Boreëlus*.

KEY TO MALES

- A. Narrowest width of front equal to length of third antennal joint; outer forceps subquadrate, less than twice as long as broad.
 - avium* (sens. lat.) n. sp.
 - a. Hairs on mesonotum one-fourth length of bristles; basicosta black. (New York)..... *avium avium*
 - aa. Hairs of mesonotum nearly half as long as bristles; basicosta orange. (Washington)..... *avium asiovora* n. var.
- AA. Narrowest width of front distinctly less than length of third antennal joint; outer forceps elongate, three to four times as long as broad.
 - B. Parafrontals contiguous (may not hold for varieties *parva* and *cuprea*; our male of *parva* is without head, male of *cuprea* unknown).
 - hirudo* (sens. lat.) n. sp.
 - b. Accessory notopleural present (Colorado)..... *hirudo hirudo*
 - bb. Accessory notopleural absent (Kansas)... *hirudo parva* n. var.
 - BB. Parafrontals well separated.....*splendida* (sens. lat.) Macquart.
 - c. Dark metallic blue; pollinose stripes but little evident on mesonotal disc.
 - d. Squamae white (U. S. generally)..... *splendida splendida* Macq.
 - dd. Squamae darkened (Washington, Brit. Columbia).
 - splendida hesperia* n. var.
 - cc. Body with a general grayish tinge; pollinose stripes evident on disc of mesonotum (Washington)..... *splendida hirunda* n. subsp.

KEY TO FEMALES

- A. Large species (11 mm.); parafacials broad, opposite second antennal joint equal in width to distance between oral vibrissae; basicosta dark brown..... *avium* (sens. lat.) n. sp.
 - a. Abdomen slightly pruinose (New York)..... *avium avium* n. var.
 - aa. Abdomen with ashy tinge (Washington)..... *avium asiovora* n. var.
- AA. Smaller (9 mm. or less); parafacials usually narrower, opposite second antennal joint equal to one-half distance between oral vibrissae; if as broad as in *avium* then basicosta is orange.
 - B. Front unusually narrow; upper frontorbital absent; accessory notopleural present..... *hirudo* (sens. lat.) n. sp.
 - b. General color dark, with rather heavy pruinosity.
 - c. Squamae darkened (Colorado)..... *hirudo hirudo*
 - cc. Squamae white (Kansas)..... *hirudo parva* n. var.
 - bb. General color bronze (Washington)..... *hirudo cuprea* n. var.
 - BB. Front normal; upper frontorbital present; no accessory notopleural.
 - splendida* Macquart.
 - c. Abdomen entirely dark blue.
 - d. Squamae white (Washington)..... *splendida hirunda* n. subsp. and (general U. S. distribution)..... *splendida sialia* n. var.
 - dd. Squamae darkened..... *splendida hesperia* n. var.
 - cc. Abdomen more or less coppery.

d. Entire body coppery (New Hampshire, Ontario)

splendida aenea n. var.

dd. Last abdominal segment only coppery (general U. S. distribution)..... *splendida splendida* Macq.

Protocalliphora avium, n. sp.

Male: Large, robust, dark steely blue, with faint pollinose longitudinal vittae on mesonotum. Head broader than high, very broadly triangular in frontal aspect. Front rather broad, at narrowest width fully equal to length of third antennal joint; frontal vitta opaque black; parafacials shining silvery pollinose and bearing, besides the frontal bristles, black hairs which continue up to the vertical bristles. Upper parafacial shining silvery pollinose, opposite second antennal joint broader than distance between oral vibrissae. Antennae dark brown, third joint darker; arista about length of antenna. Mesonotum under proper reflection with two broad longitudinal pollinose stripes, confluent anteriorly; a somewhat similar stripe present on humeri and extending backwards. Legs black. Abdomen dark blue with greenish and violet reflections. Forceps shining black, outer ones subquadrate, less than twice as long as broad; inner forceps stout, diverging apically. Wings smoky, darker basally; squamae white. Length: 11 mm.; wing 9.5 mm.

Female: Front noticeably broader than length of arista; parafrontals and upper parafacials shining pollinose with a somewhat bronzy reflection. Mesonotum and abdomen more extensively pollinose than in male. Length 11 mm., wing 9 mm.

Three males and five females. Ithaca, N. Y. Reared from nestling crows, (Cornell University Lot 1033, 108 and 108 Aa, I. D. Dobrosky). Two females Ithaca, N. Y., July 10, 1914 (probably some of Coutant's material) are provisionally placed here.

Type.—Cat. no. 26857 U. S. N. M. Paratypes in Cornell Collection.

This species may be recognized in the male by the characteristic forceps, the outer ones being much broader than in all other species of the genus. The broad front of both ♂ and ♀ likewise serve to identify this species. Otherwise it is very hard to distinguish the female from certain varieties of *splendida*.

Protocalliphora avium var. *asiovora*, n. var.

Male: Differs chiefly in its darker coloration, lighter colored basicosta, longer mesonotal hairs and the outer forceps being less truncated apically.

One male, reared from larva found in a long eared owl's nest (*Asio wilsonianus*) McElroy Lake, Paha, Washington, June 30, 1920 (R. C. Shannon). A female specimen collected at Almota, Washington (A. L. Melander) is provisionally placed here. It scarcely differs from females of *avium avium*. The abdomen is more pruinose.

Type.—Cat. no. 26858, U. S. N. M.

Protocalliphora splendida splendida Macquart.

Male: Shining dark blue. Head somewhat broader than high; front narrowed, being noticeably less, at narrowest point than length of third antennal joint; frontal vitta opaque black; parafacials and parafrontals shining silvery pollinose; parafrontals squeezed out above, thus causing a cessation

of the setae a noticeable distance below ocelli; parafrontals opposite second antennal joint as broad as distance between oral vibrissae. Mesonotum and scutellum without very evident pollinosity. Legs black. Abdomen with only faint trace of pruinescence. Outer forceps elongate (1×5) slightly tapering downwards, apex obtusely rounded. Inner forceps slender, normally paralleled. Wings darkened basally, basicosta shining brown; squamae white. Length: 10 mm.; wing, 8 mm.

Female: (variety *splendida*). Front of medium breadth, about twice as long as broad and with full complement of bristles; frontal vitta opaque, parafrontals and parafacials rather dull silvery pollinose, a well defined somewhat bronzy changeable spot opposite basal antennal joints. Width of parafacials opposite second joint about two-thirds distance between oral vibrissae. Mesonotum appearing bluish gray due to rather extensive pruinescence which under different reflections breaks up into eight longitudinal vittae, heavier and somewhat confluent anteriorly. Apical tergite brassy, preceding ones dark bronze with pruinescence. Wings faintly, smoky, darker basally; basicosta dark brown; squamae white. Length 9 mm.; wing 7.5 mm.

The above descriptions of male and female are based on specimens reared from puparia found in the nest of a brown thrasher, Rosslyn, Virginia, May 20, adults emerged May 29, 1913 (R. C. Shannon). The female was included in the type material of *metallica* whereas the male was determined as "*Phormia chrysoorrhoea*." Obviously they are male female of the same species, i. e., *splendida* Macquart. Although the female is probably atypically colored it must be considered as the typical form, it being the form described by Macquart. The distribution of all the subspecies and varieties of *splendida* is given at the end of the descriptions of this species.

Protocalliphora splendida sialia, n. var.

Female: Differs from *splendida splendida* in having the ground color of the entire abdomen deep shining blue. Usually the pruinescence of the mesonotum is less evident and the basicosta is very dark brown. This form is usually determined as *azurea* or *sordida* (*chrysoorrhoea*, *caerulea*).

Protocalliphora splendida hesperia, n. var.

Male and female: Characterized by the dusky squamae and wing bases. The pile is also somewhat longer and usually more bristle-like on mesosternum. Type.—Cat. no. 26861 U. S. N. M.

Protocalliphora splendida aenea, n. var.

Female: General color bronzy, mesonotum but little shining, abdomen well burnished; squamae and basicosta rather golden.

Type.—Cat. no. 26860 U. S. N. M.

Protocalliphora splendida hirundo, n. subsp.

Male: Forceps noticeably shorter than in *splendida splendida* and the outer ones in consequence broader in proportion to length. Front somewhat broader, the parafrontals well defined upwards until opposite lower ocellus. Basicosta yellowish brown; squamae white.

Female: Parafrontals and parafacials bronzy pollinose, without a well defined changeable spot; abdomen unicolorous; basicosta light brown; squamae white.

Type.—Cat. no. 26859 U. S. N. M.

HOSTS AND DISTRIBUTION OF *PROTOCALLIPHORA SPLENDIDA* MACQUART, (SENS. LAT).—Varieties *splendida* and *sialia*, reared specimens: 1 ♂, 2 ♀ ♀ (females: varieties *splendida* and *sialia*) host, brown thrasher (*Toxostoma rufum* L.) Rosslyn, Va., May 29, 1913 (R. C. Shannon); 1 ♂, 1 ♀ (female: variety *sialia*) larvae in nestlings of bluebird (*Sialia sialis* L.) Wellesley, Mass., August 10, 1907 (E. F. Everett); 1 ♀ (*sialia*) larva parasitic on nestling bluebird, Ottawa, Ontario, July 23, 1922 (H. Lloyd); 3 ♂ ♂, 3 ♀ ♀ (females, variety *sialia*), host, bluebird, Shawnee, on Delaware River, Pennsylvania, July 31, 1908; 8 ♂ ♂, 10 ♀ ♀ (females, variety *splendida*) host, cardinal, East Falls Church, Va., June, 1923 (E. A. Chapin); 2 ♂ ♂, 2 ♀ ♀ (females, variety *sialia*) host, robin (*Planesticus migratorius* L.) Ithaca, N. Y. June, 1922 (Shannon and Dobrosky); 30 ♂ ♂, 28 ♀ ♀, (*sialia*) hosts, crows and robin, Ithaca, New York, May, July (I. Dobrosky); 2 ♂ ♂, 4 ♀ ♀ (*sialia*) host, western horned lark (*Otocoris alpestris*) Koehler, Mew Mexico, Webster no. 7707 (W. R. Walton).

COLLECTED SPECIMENS: 1 ♀ (*sialia*), White Mountains, New Hampshire (H. K. Morrison); 1 ♂, 1 ♀ (*sialia*) Wellesley, Mass.; 1 ♂, Blue Hills Res., Mass., 1 ♀ (*sialia*) Blue Hill, Mass. (N. Banks); 1 ♂, on solidago, Stafford, Conn., August 24, 1905 (W. E. Britton); 1 ♂ McLean, New York, July 18, 1921 (R. C. Shannon); 1 ♂, Caroline, New York (E. G. Anderson); 1 ♂ Fall Creek, Ithaca, New York, April 26, 1922 (L. S. West); 1 ♂, Farmingdale, Long Island, New York, April 29, 1917 (J. Bequaert); 1 ♀ (*splendida*) Watchogue, S. I., New York, May 10, 1920 (E. J. Burns); 1 ♀ (*splendida*) West Orange, New Jersey (J. Bequaert); 1 ♀ (*splendida*) Robertson, Carlinville, Illinois; 1 ♀ (*splendida*) Milwaukee, Wisconsin; 1 ♀ (*sialia*) top of Las Vegas Range, New Mexico, 11,000 feet, end of June (T. D. A. Cockerell); 1 ♀ (*splendida*), Koehler, New Mexico (W. R. Walton); 1 ♀ (*splendida*) Moscow, Idaho, June 18, 1912 (J. M. Aldrich); 2 ♀ ♀ (*sialia*) Almota, Washington (A. L. Melander); 1 ♀ (*splendida*) Mt. Hood, Oregon, July 29, 1921 (A. L. Melander); 1 ♂, 2 ♀ ♀ (*sialia*) Savonoski, Naknek Lake, Alaska, August 1, 1919 (J. S. Hine).

Protocalliphora splendida aenea Shannon and Dobrosky. 3 ♀ ♀ Franconia, New Hampshire, (Mrs. Annie T. Slosson); 1 specimen, only mesonotum and wings remaining, probable ♀, "from brain of a living fledgling of sparrow kind," Ontario, (And. Halket).

Protocalliphora splendida hesperia Shannon and Dobrosky. A large series of this variety was reared from a number of species of birds in region of Seattle, Washington, summer 1918 (O. E. Plath). 1 ♂, 5 ♀ ♀, Ainsworth, British Columbia, July 11, 1903 (A. N. Caudell).

Protocalliphora splendida hirundo Shannon and Dobrosky. 35 ♂ ♂, 29 ♀ ♀, host, cliff swallow (*Petrochelidon albifrons* Say, many nests examined had dead remains of young), Stratford, Washington, July 4, 1920 (R. C. Shannon).

Protocalliphora hirudo n. sp.

This species (including the three varieties here recognized) is characterized by its smaller size, 8 mm., usually less, the unusually narrow front in both sexes (males always?), absence of the upper frontorbital in the female and the presence of an accessory bristle on the notopleura (except male of *parva*) which is smaller than and located between the usual two. Apparently only of western distribution.

Protocalliphora hirudo hirudo (sensu stricto)

Male: Entirely very dark shining blue; frontal aspect of head broadly oval, flattened on upper half; parafrontals contiguous; parafacials silvery pollinose, a slight trace of yellow present, equal to one-half distance between oral vibrissae; mesonotal vittae very faintly indicated; abdomen entirely shining; forceps very slender; wings and squamae distinctly smoky.

Female: Front about three times as long as broad; mesonotum and abdomen with perceptible pruinescence; wings and squamae smoky. Length 6-7 mm.; wing 6-7.5 mm.

Type.—Male, reared from nestling warbler, Colorado, July 10, 1911, (M. A. Palmer); allotype female (same, both from collection of W. R. Walton); paratypes: one male and three females (kindly loaned by Dr. J. Bequaert) reared from maggots found in sparrow Colorado Springs, Colorado, August, 1916 (W. W. Arnold); one male, two females, Kochler, New Mexico (Webster no. 7707, W. R. Walton).

Type.—Cat. no. 26862 U. S. N. M.

Protocalliphora hirudo parva n. subsp.

Male: Dark shining blue; forceps fairly long and slender; angle in last section of fourth vein not sharply angulated; basicosta light brown; squamae tinged. Length about 6 mm.; wing 5 mm.

Female: Head broadly oval, face but little protruding downwards; front narrow, nearly three times as long as broad; arrangement of frontorbitals abnormal, the upper one, on right side, opposite lower ocellus, upper one on left side absent, lower two pairs irregular in their relation to each other; parafrontals and parafacials somewhat ashy, without well defined changeable spot, at their broadest width, opposite second antennal joint, much less than width between oral vibrissae. Pruinescence on mesonotum extensive, giving a general ashy appearance. Wings as in male; squamae white. Length about 6 mm.; wing 5 mm.

Unfortunately the head is lacking in the male and the abdomen in female.

One male and one female, reared from fledglings, Kansas, (S. W. Williston through Prof. L. L. Adams).

Type.—Cat. no. 26864 U. S. N. M.

Protocalliphora hirudo cuprea n. var.

Female: Characterized by its general bronzy color and yellowish wing bases and squamae (coloration very similar to *P. splendida aenea*) and a pair of distinct pollinose mesonotal vittae. Length 7.5 mm.; wing 7 mm.

Reared from pupa in nest of western robin (*Planesticus migratorius propinquus*) Seattle, Washington (O. E. Plath).

Type.—Cat. no. 26863 U. S. N. M.